PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Improvements relating to Printed Circuits

We, BRITISH AIRCRAFT CORPORATION (OPERATING) LIMITED, a British company, of 100, Pall Mall, London, S.W.1., do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement: —

Printed circuits are normally formed by the application of a photomilling technique (that is to say, photo-lithography followed by etching) to a layer of conductive material, or by the use of electron beaming techniques. For large and complicated circuits a multi-layer construction is often necessary and it is then essential to provide reliable interconnections between the conductive planes of the multi-layer circuit.

At present, some methods of connection necessitate drilling holes of accurate dimensions through insulating boards at accurately known positions. Other techniques, such as electro-less through-plating do not control the production of the joints individually but use chemical means to make a number of joints simultaneously. A further technique employed when two conductive planes lie on opposite sides of an insulating layer is to connect the conducting planes together by pinch welding them through appropriate holes in the insulator. This method has the disadvantage that the structure must be accessible from both sides to allow the welding electrodes to operate, and the further drawback that the distortion of the conducting members consequent upon the pinch welding introduces the possibility of mechanical fracture.

According to the present invention, a connection between the conductive layers in a multi-layer printed circuit board or a double-sided printed circuit board is produced by forming a hole through an insulating layer, which is to form an intermediate layer between the conductive layers; forming one of the conductive layers with a portion of greater thickness than the remainder of the layer in a position corresponding to the position of the hole in the insulating layer, the said portion projecting from the remainder of the layer by an amount substantially equal to the thickness of the insulating layer; arranging the insulating and conductive layers so that the projecting portion of one conducting layer extends through the hole to the undersurface of the other conducting layer; and heating the outer surface of the said other conducting layer at the locations of the hole and the projection to form a joint between the undersurface of the other conducting layer and the projecting portion of the first conducting layer.

This method has the advantage that joints can be made by the application of a tool to one surface only, thereby making possible the fabrication of multiple laminates or double-sided printed circuit boards. It also avoids the distortion consequent upon pinch welding and does not require a high degree of accuracy of mechanical machining. Portions of greater thickness are preferably formed by a subtraction technique, that is to say by removing metal from the conductive layer except at the locations of the required portions of greater thickness. Additive methods could however be used to build up the projecting portions.

In order that the invention may be better understood, one example will now be described with reference to the accompanying drawings. In the drawings: —

Figure 1 is a section through a printed circuit board made by the pinch welding technique.

Figure 2 illustrates a step in the production

[*Price* 4*s.* 6*d.*]

of printed circuit boards by the method of the present invention.

Figure 3 shows the formation of a joint between the parts shown in Figure 2; and

Figure 4 illustrates a later stage in the construction of a multiple layer board.

In Figure 1, the conductive layers 3 on opposite sides of the insulating layer 2 are inter-connected at joints 1 in holes in the insulating layer. These interconnections are formed by pinch welding the conductive layers at the locations of the holes by means of electrodes on opposite sides of the laminated board shown in Figure 1.

As explained above, the pinch welding results in distortion and possible mechanical failure of the conductive layers.

In the example illustrated in Figures 2 to 4, a printed circuit board is formed in the usual way by etching or electron beam machining, to leave a network of conductors on an insulating base. This is repeated for each of the layers requried in the final multi-layer structure, each layer consisting of an insulating base supporting a conductive network. Each insulating base, except the lowest in the stack will have been formed with apertures where connection is required between the circuit which it supports and a circuit which will underlie the base in the final structure. The conductive layer on the base which forms the circuit is etched away for part of its thickness, except at the points where the interconnections are desired, to leave areas projecting from the surface at these interconnection points.

Two such layers are illustrated in Figure 2, where the conductive circuit members are indicated at *4a* and *4b* and the insulating bases at *5a* and *5b*. It will be appreciated that in Figure 2 these layers are shown in cross section and that in plan view it would be seen that the conductive members *4a* and *4b* constitute conductive networks on the insulating bases *5a* and *5b*.

In Figure 2, the insulating base *5b* has been formed with an aperture 6 to permit connection between the two layers, and the conductive member *4a* has been etched away for a part of its thickness except at the portion 7, which has been left projecting from the upper surface of this conductive member to an extent substantially equal to the thickness of the insulating layer *5b*.

In Figure 3, the two layers have been brought together and a welding electrode 8 has been placed on the surface of the conductive layer *4b* immediately above the projecting portion 7 of the conductive member *4a* and a joint 9 has been formed between the upper surface of the projection and the undersurface of the conductive member *4b*.

Figure 4 shows a later stage in the construction of a multi-layer board, in which a further layer consisting of the conductive member *4c* on the insulating base *5c* has been placed on the conductive member *4b*, with the projecting portion 7 of the latter extending through the aperture 6 in the base *5c*. The welding electrode 8 is in position for forming a further joint to connect the conductive members *4b* and *4c*. It will be clear that the process can be repeated for as many layers as are required and that it gives rise to a none of the distortion evident in Figure 1.

WHAT WE CLAIM IS:—

1. A method of forming a connection between the conductive layers in a multi-layer printed circuit board or a double-sided printed circuit board comprising: forming a hole through an insulating layer, which is to form an intermediate layer between the conductive layers; forming one of the conductive layers with a portion of greater thickness than the remainder of the layer in a position corresponding to the hole position on the insulating layer, the said portion projecting from the remainder of the layer by an amount substantially equal to the thickness of the said insulating layer; arranging the insulating and conductive layers so that the projecting portion of the said conductive layer extends through the hole to make contact with the underside of the other conductive layer; and heating the outer surface of the overlying conductive layer at the location of the hole and the projection to form a joint between the undersurface of this layer and the said projection.

2. A method in accordance with Claim 1, in which the said projection is formed on the conductive layer by removing some of the conductive material over the whole of the layer except where the projection is required.

3. A multi-layer or double-sided printed circuit board in which one of the conductive layers includes an integral stub portion extending through an intermediate layer of insulating material to make contact with the underside of the conductive layer on the other side of the intermediate layer, the stub portion projecting above the remainder of its layer by an amount substantially equal to the thickness of the intermediate layer, and in which the two conductive surfaces are welded together by heating the overlying conductive layer at the location of the stub portion to form a joint between the undersurface of this layer and the said stub portion.

4. A method of forming a connection between the conductive layers in a multi-layer printed circuit board, substantially as herein described with reference to Figures 2 to 4.

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1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

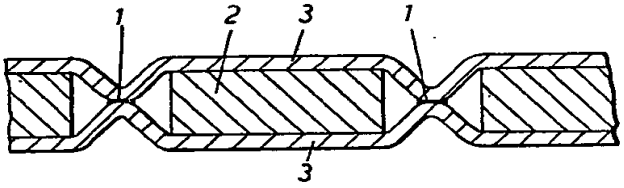

FIG.1.

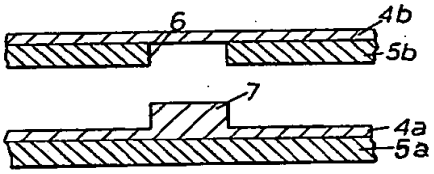

FIG.2.

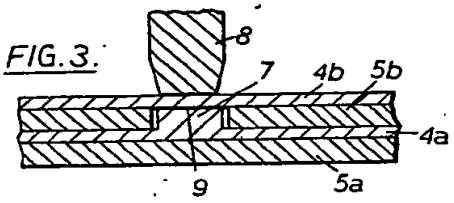

FIG.3.

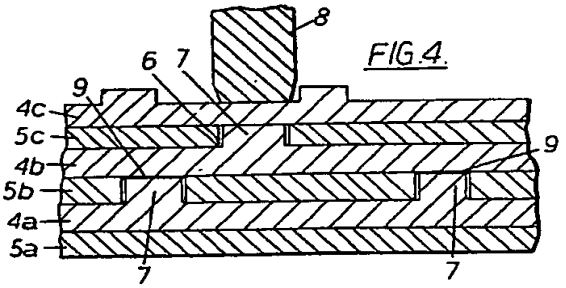

FIG.4.